Aquidneck Island

Broadband Analysis and Recommendations

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Report prepared by:

TILSON

On behalf of:

EA Engineering, Science, and Technology, Inc.

BBRI is a project of the Rhode Island Department of Administration Office of Digital Excellence in partnership with Rhode Island Commerce Corporation and is funded by the US Department of Commerce National Telecommunications and Information Administration (NTIA)

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Note

Cost information included in the following report is an estimate based on recent quotes, historical data, certain assumptions about the project scope and approach, the regulatory environment and market conditions at a fixed point in time. Given these variables, we recommend updating the estimate as time passes, and allocating sufficient contingency to allow for inevitable but unpredictable changes in the cost environment if the project moves forward.

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Executive Summary

Broadband Rhode Island (BBRI), part of the Rhode Island Office of Digital Excellence (ODE) has engaged EA Engineering Science, and Technology, Inc. (EA) to perform data collection and broadband mapping for Rhode Island as part of the State Broadband Initiative (SBI), a federally-funded NTIA grant. As part of that work, EA engaged Tilson to survey broadband assets on Aquidneck Island, conduct a needs analysis of the community, articulate gaps in service, and provide high-level solutions and cost estimates for closing the gap.

Several entities in the community have expressed interest in analyzing Aquidneck's broadband services and diagnosing performance gaps. Interested constituencies include the Newport IT Working Group, the Newport County Chamber of Commerce, the Aquidneck Island Planning Commission, and the city and town governments on the island.

Tilson understands that Aquidneck Island, and its communities of Middletown, Newport and Portsmouth are a key region to the state's economic health and viability.

The key findings of the study are as follows:

1. There is abundant fiber and tower infrastructure in close proximity to businesses on the island.

2. Web-surfing capable service is offered everywhere, however realized speeds, reliability and pricing is widely perceived to be insufficient.

3. Newport County is the only county in the state with only one cable TV provider. All other counties are served by at least two providers (e.g. Cox, Full Channel, Verizon FiOS). Since cable TV providers are well positioned to offer broadband with their current infrastructure, a dearth of competition in wireline cable providers negatively affects broadband competition.

4. BBRI's previously collected speed test data support a slower-than-norm download speed for both Newport County as a whole, and the three towns on Aquidneck. Further, it appears that Cox customers on Aquidneck Island experienced slower speeds than Cox customers elsewhere in Rhode Island.

5. Aquidneck's dense commercial settlement pattern combined with recent OSHEAN footprint make for a relatively low capital cost to improve service to businesses on the island.

6. Tilson's high-level capital cost estimate for a wireless infrastructure that covers the entire island is between $1.6 and $3.2 million. This would provide an alternative broadband service that would surpass current service offerings.

7. A fiber to the premise (FTTP) infrastructure for the entire island would cost between $70.1 and $106.4 million. This network would provide state of the art technology that would meet the broadband needs of every resident on the island for a generation. This network could also be deployed incrementally at lower costs.

8. Tilson estimates that it would cost $3.4 to $7.9 million annually to operate a FTTP network and between $2.4 and $4.1 million to operate the wireless network. It is extremely difficult to accurately estimate these costs without a final business model that defines ownership rights, taxes, revenue sharing, and cost of capital. These estimates represent a best effort utilizing comparable figures.

9. Proven business models have the potential to dramatically reduce the cost of high speed broadband. High end broadband service currently costs several hundred to several thousand dollars. Gigabit Ethernet service is offered in select cities throughout the country for as low as $70 per month.

10. Numerous studies have established a link between broadband investments and economic growth. Broadband access increases productivity, creates jobs and enhances consumer well-being. Extrapolating from existing studies, Tilson estimates the total 10 year benefit of a new island-wide network to be between $525 million and $2.020 billion.

11. Tilson identified four potential business models for improving broadband service. They are:

    - Private Model. An Internet Service Provider (ISP) uses its own capital to build its own broadband network using a combination of OSHEAN fiber, wireless assets, and/or new fiber. The ISP operates its network in competition with current providers.
    - Public Model. Local or regional government funds, builds and operates broadband network. This would likely require the hiring of new government staff or contractors.
    - Public/Private Partnership. A local or regional government entity funds and builds broadband network. A private ISP operates network.
    - Non-Profit OSHEAN Reseller. A non-profit resells OSHEAN internet access service to commercial customers within OSHEAN's distance parameters. Non-profit may consider offering wireless-based broadband to residential customers based on a more involved model.

Defining Broadband

It is important to note that the term "broadband" does not refer to any technology in particular. Rather it refers to data transmission through a medium in excess of certain threshold. From an information technology perspective, it represents the amount of data that a consumer can download or upload from the internet in a given second. This is the measurement known as bandwidth. Greater bandwidth is analogous to a faster connection. Connection speeds are generally measured in kilobits per second (Kbps), megabits per second (Mbps) or gigabits per second (Gbps).[1]

In the U.S., broadband standards are defined by the Federal Communications Commission (FCC), which regulates interstate and international communications by radio, television, wire, satellite and cable. The FCC uses a tiered approach to define broadband based on download and upload speeds for wireline and wireless technologies:

FCC Speed Tier	Download Speeds	Upload Speeds
1st Generation Data	200 Kbps to 768 Kbps	200 Kbps to 768 Kbps
Tier 1	768 Kbps to 1.5 Mbps	768 Kbps to 1.5 Mbps
Tier 2	1.5 Mbps to 3 Mbps	1.5 Mbps to 3 Mbps
Tier 3	3 Mbps to 6 Mbps	3 Mbps to 6 Mbps
Tier 4	6 Mbps to 10 Mbps	6 Mbps to 10 Mbps
Tier 5	10 Mbps to 25 Mbps	10 Mbps to 25 Mbps
Tier 6	25 Mbps to 100 Mbps	25 Mbps to 100 Mbps
Tier 7	> 100 Mbps	> 100 Mbps

Table 1: FCC Speed Tiers

The FCC currently defines 4 Mbps downstream and 1 Mbps upstream as the minimum threshold speeds for broadband. As shown in the table above, the current standard translates to a minimum Tier 3 download and Tier 1 upload connection to qualify as broadband service. In July of 2014, the FCC announced that it planned to increase the download threshold to 25 Mbps. They have yet to issue a position on the upload threshold.[2] This redefinition has the potential to dramatically increase the number of communities in the U.S. eligible for subsidy.

The rapid advancement of delivered data speeds in the U.S. is causing the FCC to recently change the definition of broadband. In 2000, only 4.4 percent of American households had a broadband connection (as currently defined) in their homes. By 2010, that number had jumped to 68 percent. Moreover, since 2010, average delivered speeds in the U.S. have doubled overall, and today roughly 94 percent of Americans have access to wireline or wireless broadband speeds of at least 10 Mbps downstream. As a result, the FCC raised the minimum threshold for download speeds from Tier 1 to Tier 3 in 2010, and is now considering increasing the downstream threshold to Tier 5.[3] This evolving baseline reflects a

[1] 1 Gbps = 1000 Mbps = 1,000,000 Kbps.

[2] As this document was going to publication, the FCC increased its broadband definition to 25 Mbps download, 3 Mbps download. http://www.fcc.gov/document/fcc-finds-us-broadband-deployment-not-keeping-pace

[3] Pg. 4. *Four Years of Broadband Growth*, June 2013. The White House Office of Science and Technology Policy & The National Economic Council.

growing need for higher bandwidth as Americans increasingly use the internet and communications technologies in all aspects of their lives.

In terms of functionality, the following table shows download speeds required for a range of common internet-based activities:

	Basic Use (Email, Web Surfing Basic Video)	Moderate Use (Basic use plus high demand functions i.e. gaming, conferencing, HD video)	Heavy Use (Basic use plus multiple high demand functions)
1 user on 1 device (laptop, tablet, gaming console)	1 – 2mbps	1 – 2mbps	6 – 15 mbps
2 users on 2 devices at a time	1 – 2mbps	1 – 2mbps	6 – 15 mbps
3 users on 3 devices at a time	1 – 2mbps	2 – 5 mbps	15 mbps or more
3 users on devices at a time	2 – 5 mbps	6 – 15 mbps	15 mbps or more

Figure 1: Minimum Download Speed for Common Activities[4]

[4] FCC, Household Broadband Guide.

Future Broadband Speed Projections

Future demand for increased download speeds is projected to grow dramatically as adoption of existing services grows, as consumers continue to increase the number of connected devices,[5] and as new services, such as monitoring and surveillance applications, are introduced.

One extensive study commissioned by Cable Europe and NLkabel forecasted the future average sufficient provisioned residential broadband speed in the EU given factors of adoption rates, connected devices, urgency of traffic (the tolerance for time required to transmit data), and future services.[6] Download speeds increase rapidly are were forecasted to be at Tier 5 in 2015. Average sufficient upload speed demand grows more slowly as this type of traffic typically has less urgency for the residential user (i.e. placing large files in cloud storage versus downloading a movie). Business users using the internet for tasks like cloud computing, real time backup and video conferencing require faster upload speeds and demand symmetrical connections.

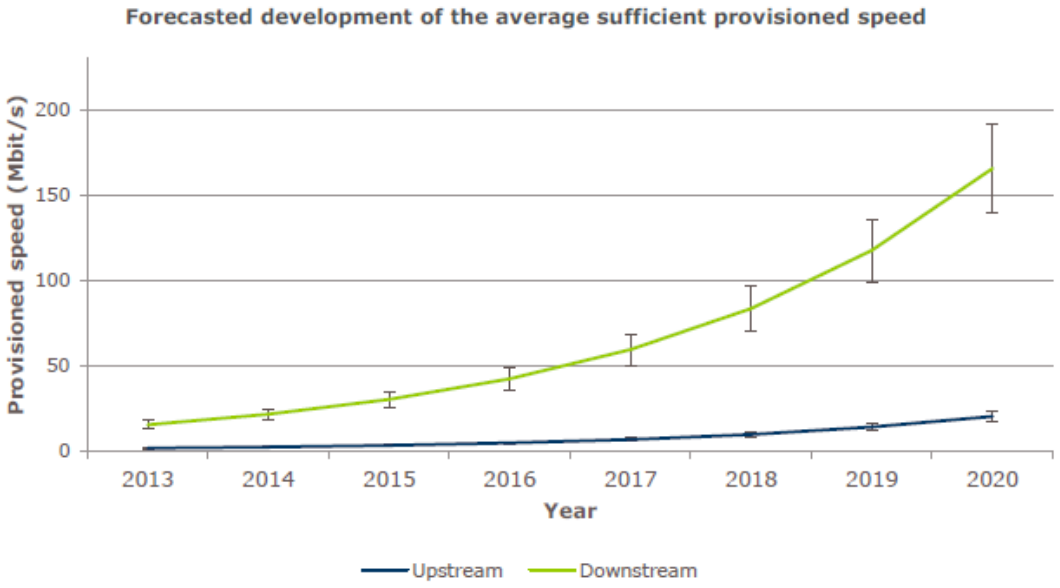

Figure 2: Forecasted Demand of Average Residential Broadband Connection Speed

Download and upload speed capability depend on the type of technology service providers utilize. There are a number of different technologies currently available to residential and business users, which offer varying bandwidth capabilities. As users demand increasingly fast connection speeds, the technology used to deliver those speeds will shift towards the bottom of the following table:

[5] Annual Cisco Visual Networking Index Forecast: In North America, there will be 9.3 networked devices per capita in 2018, up from 5.3 per capita in 2013.

[6] "Fast Forward: How the Speed of the Internet will Develop Between now and 2020", June 2014, van der Vorst et. Al.

Technology	Download & Upload Speeds
Dial-up	Up to 56 Kbps
2G Mobile	Up to 100 Kbps
3G Mobile	384 Kbps – 2 Mbps
4G Mobile[7]	2 Mbps – 18 Mbps
Satellite[8]	200 Kbps – 2 Mbps
T-1	1.5 Mbps
DSL	768 Kbps – 7 Mbps
Traditional Cable	1 Mbps – 10 Mbps
DOCSIS 3.0 Cable	1 Mbps – 150 Mbps
Fixed Wireless[9]	1 Mbps – 1.5 Gbps
Fiber Optic	Up to 1,000 Gbps. Effectively infinite

Table 2: Technological Speed Capabilities[10]

[7] AT&T Wireless currently has the highest tested capacity at 18 Mbps.

[8] Current satellite service may achieve broadband level speeds, but the excessive latency or delay precludes the use of many broadband applications.

[9] The Rhode Island company Towerstream offers up to 1.5Gbps.

[10] The speeds are typical ranges achieved for each technology. Higher speeds will be possible for certain technologies given future innovation. The top ranges represent optimal network layout and user saturation. For example, DSL users close to a network node during a period of low network use will obtain higher connection speeds. Outside of one mile from a network node, it is very difficult to achieve a broadband connection over DSL.

Telecom Inventory

This section details the assets and services of facilities-based carriers providing broadband service. Most municipalities in the U.S. have broadband options from an incumbent local exchange carrier (phone) and cable company (TV) for broadband service. On Aquidneck Island, these providers are Verizon and Cox Communications respectively. They offer a suite of business and residential internet and voice products. Cox offers video products. In addition to these options, Towerstream provides a wireless broadband option to businesses on the island and the publicly funded OSHEAN network connects educational, public safety, non-profit, and government institutions.

Verizon

Residential: Verizon offers copper-based DSL to most or all addresses on the island. The fastest residential advertised (and available) DSL promotion is 3.1 to 7 Mbps download, 768 kbps upload. Speeds are not guaranteed, and are a function of distance to the central office, the size and type of copper, and the condition of the copper infrastructure. Verizon does not offer its FiOS Service on the island and has no plans to expand service. [11] [12]

Commercial: In addition to DSL, Verizon will supply fiber-based connections, up to 1 Gbps of symmetrical service[13], anywhere on the island. The price and time required to provision are on a case-by-case basis. In most cases, a fiber lateral is built from a network Point of Presence (POP) in the street to the customer premises. Verizon's quote for this service appears in the Pricing of Broadband Service Offering summary table below. [14]

Key Assets: The Verizon network covers the majority of the island servicing residential customers with copper wired line Telephony and DSL data services. The Verizon fiber network is not visible throughout the island and appears limited in many areas. Verizon has large fiber sheaths along sections of East Main Street (RT 138), some fiber along portions of West Main St (RT 114) and along some commercial areas, albeit limited. It appears that there is fiber connecting Verizon's central offices, which transports telephony and DSL between central offices.

Cox Communications

Residential: Cox offers a self-described best efforts[15] service to all addresses on the island using its DOCSIS 3 hybrid fiber/coaxial cable network. According to a Middletown-based Cox customer service representative, Cox's network was upgraded from DOCSIS 2.0 in the summer of 2014. Top advertised

[11] FiOS is a fiber to the premises service offering symmetrical broadband speeds of up to 500 Mbps, voice, and TV programming. It is offered in the nearby mainland community of Narragansett.

[12] Conversation with Tom Kogut, RI PUC 11.18/2014; and http://consumerist.com/2014/03/12/dont-count-on-verizon-fios-coming-to-your-town-anytime-soon/

[13] Symmetrical service is where download and upload speeds are the same. E.g. 50 Mbps symmetrical means that the customer will be able to both upload and download data at 50Mbps.

[14] A Verizon business sales representative quoted fiber-based 50Mbps/50mbps service to the Aquidneck Corporate Park in Middletown, for $1800/mo, no installation fee, and a three year term.

[15] As described by Cox account representative. Terms on website include: "Cox cannot guarantee uninterrupted or error-free High Speed Internet service or the speed of your service. Actual speeds vary."

speeds on the upgraded DOCSIS 3.0 network are 150 Mbps download, 20Mbps upload. Actual speeds are determined by network configuration, data traffic congestion, the condition of the copper facility, and customer premise equipment.

One aspect of network configuration is how many subscribers are served from a fiber-fed node. As data demands have increased over time, the number of active subscribers designed into a typical cable provider's network have decreased from 500+ to 250, to as few as 125 today. The optimal number of users per node is dependent on subscriber rates. Another aspect is how the nodes are combined and routed in the Cox network's head end, where the fiber from the nodes terminates.

Data traffic congestion is the term for multiple simultaneous data demands that results in slower speeds. This is directly related to user demand and network configuration. Many cable modem customers experience congestion in the evening, when users are home from school and work. On Aquidneck, users complain of evening slowdowns and added seasonal slowdowns during the summer tourist season. [16] [17]

The condition of the network for the best efforts service refers to the coaxial cable and amplifiers between the node and subscribers' cable modems. Coaxial cable is a cable with a copper clad center conductor which the signals travel on, surrounded by foam dielectric, covered with an aluminum sheath and then covered by a PVC jacket. The coaxial cable performance diminishes in wet conditions. Salt water exposure corrodes the cable and diminishes performance further. This weathering tends to be one of the biggest maintenance issues for cable companies as their coax plant ages.

Customers require a DOCSIS 3.0 compatible modem, which they can rent or buy, in order to achieve advertised speeds.

Commercial: In addition to its DOCSIS 3.0 hybrid fiber/coax network business offerings, Cox offers business optical fiber service. The local Cox sales representative did not return requests for comment. However, Tilson believes that Cox has fibers available for dedicated customer connections along the OSHEAN route[18], plus in several other locations, such as to the Navy property in Newport. The Pricing of Broadband Service Offering summary table below contains a quote made for this service in 2013 that was made available to Tilson.

Key Assets: The Cox network covers the majority of the island in both residential and commercial business locations. This coverage is in the form of fiber to the node with a hybrid fiber/coaxial (HFC) cable network architecture providing DOCSIS 3.0 data transfer rates (see table in "Defining Broadband" section above). Cox's fiber feeding its HFC network is ubiquitous on the island. Fiber from this network can also be seen running to individual businesses subscribing to optical services, e.g. A2B Solutions. Cox also has a backbone fiber network that consists of and an overlay on the OSHEAN network,[19] and some

[16] Stoneacre Pantry, Newport. Restaurant pays $160/month for fastest best efforts Cox Service. During weekends internet connection slows, and web-dependent functions like credit card transactions take as long as 15 minutes to process, and streaming music stops. Per phone conversation with David Crowell, owner of Stoneacre Pantry in Newport on 11/19/2014

[17] Ron Corriveau, conversation on 10/27/2014; Susan McDonald email 11/18/2014; Jim Egan 12/05/14.

[18] Cox won the contract to build the OSHEAN network, and during construction laid its own cable along much of the OSHEAN route.

[19] Cox built the OSHEAN network, and during that process built an overlay network of its own fiber. Cox's fiber is actually lashed to the OSHEAN fiber along the OSHEAN route.

below-ground fiber near the Navy facility in Newport. The figure below show's Cox's backbone fiber as well as large count laterals connecting the Navy facilities and running up Route 114. In addition to this backbone fiber, Cox has numerous fiber laterals running throughout the three Aquidneck Island communities. Tilson's field survey found the Cox fiber running along most every street on the island. Cox will sell fiber connections utilizing this infrastructure on a site by site basis. The Cox backbone fiber network can be seen juxtaposed against the OSHEAN network in Appendix A.

Recent Announcement: On December 18, 2014, the Newport Daily News reported that a spokesman for Cox stated that the company is planning to bring high-speed fiber-optic broadband Internet service to homes across Aquidneck Island by the end of 2016. See article in Appendix B.

Figure 3: Cox Backbone Fiber Network

Towerstream

Commercial: Towerstream provides digital microwave (wireless)-based service to customers that have line-of-sight to its two towers on the island. According to a Towerstream representative, line of sight is

available to customers on flat, treeless expanses like office parks and customers in tall buildings with a profile that accommodates an antenna that is clear of interference. Towerstream will provision one receiver to serve multiple tenants in a building by running fiber from the receiver to the customer premises. Towerstream can provide this service at a lower average cost per customer, and in fact the company provides discounts to customers in multi-tenant locations. Symmetrical speeds are available up to 1.5 Gbps. Towerstream uses licensed spectrum, and must apply for an FCC license for connections greater than 20 Mbps. Prices are lower than Cox or Verizon in terms of price per mbps for dedicated symmetrical internet access. See Broadband Service Offering summary table below for sample price points. Note that Towerstream may be a potential operator of the wireless broadband network described in the Network Design section.

Key Assets:

Towerstream's key assets on Aquidneck are two towers, one in the northern part at Bay View Apartments, 2121 West Main Road Portsmouth, RI 0287. The second covers much of the southern geography of Aquidneck from the Newport Hospital, 11 Friendship St, Newport, RI 028401. The map below shows the coverage delivered by Towerstream's two towers on the island.[20]

Figure 4: Towerstream Network

OSHEAN

OSHEAN is a consortium of universities, hospitals and government agencies that operates a 450 mile fiber optic network to serve nonprofits, health-care organizations, and educational institutions. These customers are known as "Community Anchor Institutions" (CAIs). OSHEAN offers connection speeds of up to 1Gbps.

Although OSHEAN's lit network is only open to a limited class of organizations, it does offer indirect options for expanding service on the island to private businesses and homes. OSHEAN's fiber is available

[20] Towerstream website.

for wholesale lease, and OSHEAN will resell its internet access service to a non-profit or government entity. These possibilities will be discussed later in the report.

Figure 5: OSHEAN Fiber Network on Aquidneck Island

Last Mile Resellers

Verizon and Cox supply local loops to other carriers without last mile infrastructure on the island. For example, Earthlink does not have fiber on the island, but is able to quote prices for its IP-based services using fiber to the premises that it buys from either Verizon or Cox, and resells as a bundled offering to its customer. In most cases, the provision of resold optical services requires running fiber between the Verizon or Cox POP to the customer premises. Earthlink representatives are able to identify local loop

providers and quote the price of optical services using a desktop tool. Provision of service often takes several weeks.[21]

Wireless Phone Providers

Of the four providers on the island, Verizon, AT&T, and Sprint advertise 4GLTE network on Aquidneck Island. 4GLTE networks are capable of replacing wired networks when users configure phone as a hotspot. Maximum signal strength on AT&T's network has been tested at 18.5/9 Mbps.[22] However, speed varies as a function of distance to towers and traffic congestion. The cellular antenna and radio equipment performance suffers when servicing more than a few hundred users. Verizon is currently planning the deployment of a new network of "small cells" in Rhode Island that will dramatically improve cellular performance.

Mobile 4GLTE service does not support business broadband needs. This is because mobile device generated network congestion varies widely, especially in a town like Newport with seasonal and event-driven cell phone usage.

Existing Tower Assets on the Island

Aquidneck Island has five towers that are utilizing spectrum registered with the FCC. These towers are used for mobile phone networks and the Towerstream network. They have the potential to be used for an additional wireless broadband network on the island. If these towers have space for additional antenna arrays (known as "rad sectors" in the industry), they may be an option for a wireless residential and business broadband solution. The figure below shows the locations of tower assets on Aquidneck

[21] Conversation with Earthlink Business Technology Consultant on 10/14/2014

[22] http://www.cnet.com/news/at-t-outshines-verizon-in-4g-lte-speed-tests/

Island and their approximate service range, assuming 5.8 ghz spectrum. The major cellular carriers utilize frequencies that propagates farther than 5.8 ghz, so these radiuses are conservative.

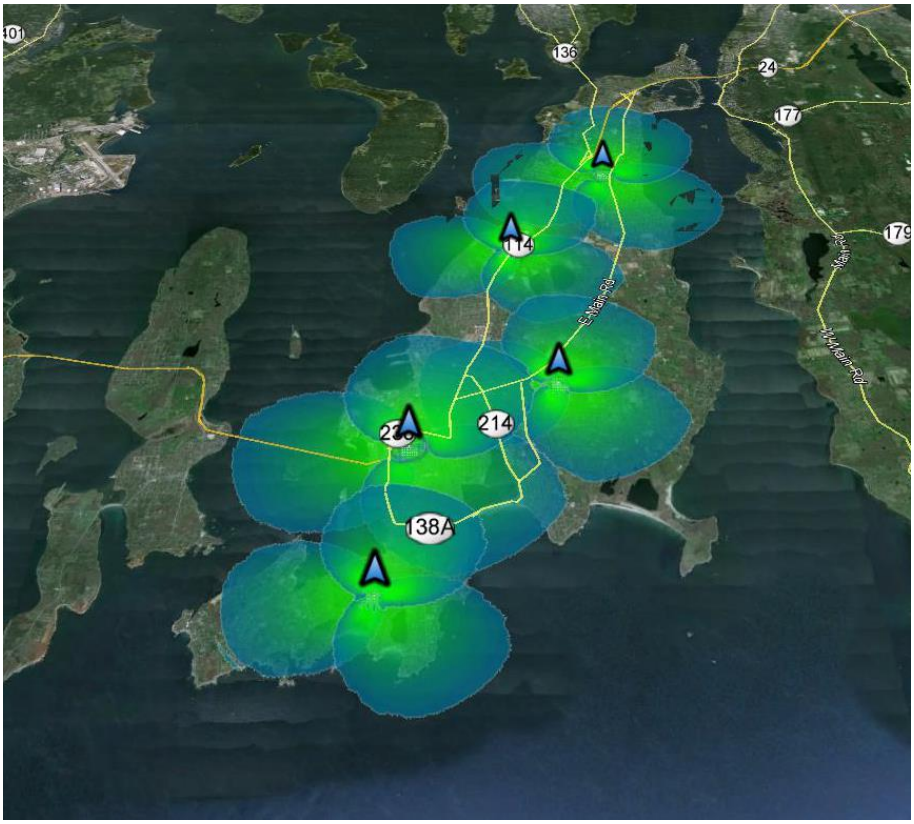

Figure 6: Existing Tower Assets and Approximate Service Range

Summary of Broadband Service Offerings on Aquidneck

Below is a table of the providers discussed above. It is important to note that the only commercial entities served by OSHEAN are healthcare providers, and Towerstream is a wireless service.

	Verizon	Cox	Towerstream	OSHEAN	Mobile Wireless
Commercial > 100 Mbps	x	x	x		
Education, Medical, Non-Profit, Gov > 100 Mbps	x	x	x	x	
Commercial 10> <100 Mbps	x	x	x		
Residential > 10 Mbps		x			
Roaming > 10 Mbps					x

Table 3: Facilities-Based Broadband Speed Offerings by Carrier on Aquidneck

Pricing of Broadband Service Offerings

Tilson was able to obtain pricing from various sources including websites, sales reps, and prospective customers. Tilson was not able to obtain OSHEAN pricing, and excluded wireless plans due to their limited relevance.

Cox Business	Speeds (down/up)	Delivery Method	Monthly Price	Notes
	15/5		n/a	
	30/10	best efforts	$75	+ installation and modem, 2 yr term
	60/15	best efforts	$135	+ installation and modem, 2 yr term
	100/20		n/a	
	2/2	optical	$460	3 yr term, bid dated Sept. 2013
	up to 10 Gbps	optical	n/a	

Cox Residential	Speeds (down/up)	Delivery Method	Monthly Price	Notes
	5/1	best efforts	$35	2 yr term, price increases $10 in year 2
	50/5	best efforts	$50	2 yr term, price increases $10 in year 2
	100/10	best efforts	$70	2 yr term, price increases $12 in year 2
	150/20	best efforts	$80	2 year term, price increases $20 in year 2

Verizon Residential	Speeds (down/up)	Delivery Method	Monthly Price	Notes
	5/.768	dsl	$30	plus installation and router

Verizon Business	Speeds (down/up)	Delivery Method	Monthly Price	Notes
	50/50	dedicated fiber	$1,800	quote from rep to Aquidneck Office Park

Towerstream	Speeds (down/up)	Delivery Method	Monthly Price	Notes
	100/100	wireless	$1,800	single tenant
	100/100	wireless	$700	10 tenants on premise

Table 4: Advertised and Quoted Broadband Prices by Carrier on Aquidneck

Tilson conducted a limited survey of ISP pricing for dedicated, symmetrical bandwidth outside of Aquidneck. That survey included two services in downtown Boston, and Google Fiber, Taunton Municipal Lighting Plant (TMLP), and Verizon FiOS residential and small business. Downtown Boston, like Aquidneck Island, is not served by FiOS, Google or a municipal utility offering like TMLP.[23]

[23] Towerstream pricing for a premise with 10+ customers decreases to $700/mo for 100Mbps. One, two or three year terms apply for most offerings.

The discrepancy in prices, shown in the table below, was big enough to necessitate a logarithmic scale to depict graphically.[24] The lowest prices are for services like FiOS, municipal utility offerings, and Google Fiber where concentrated deployment within "fiber hoods" took place. Boston, like Aquidneck, does not have Verizon FiOS. Wicked Bandwidth is a startup ISP with 10 buildings on-net.

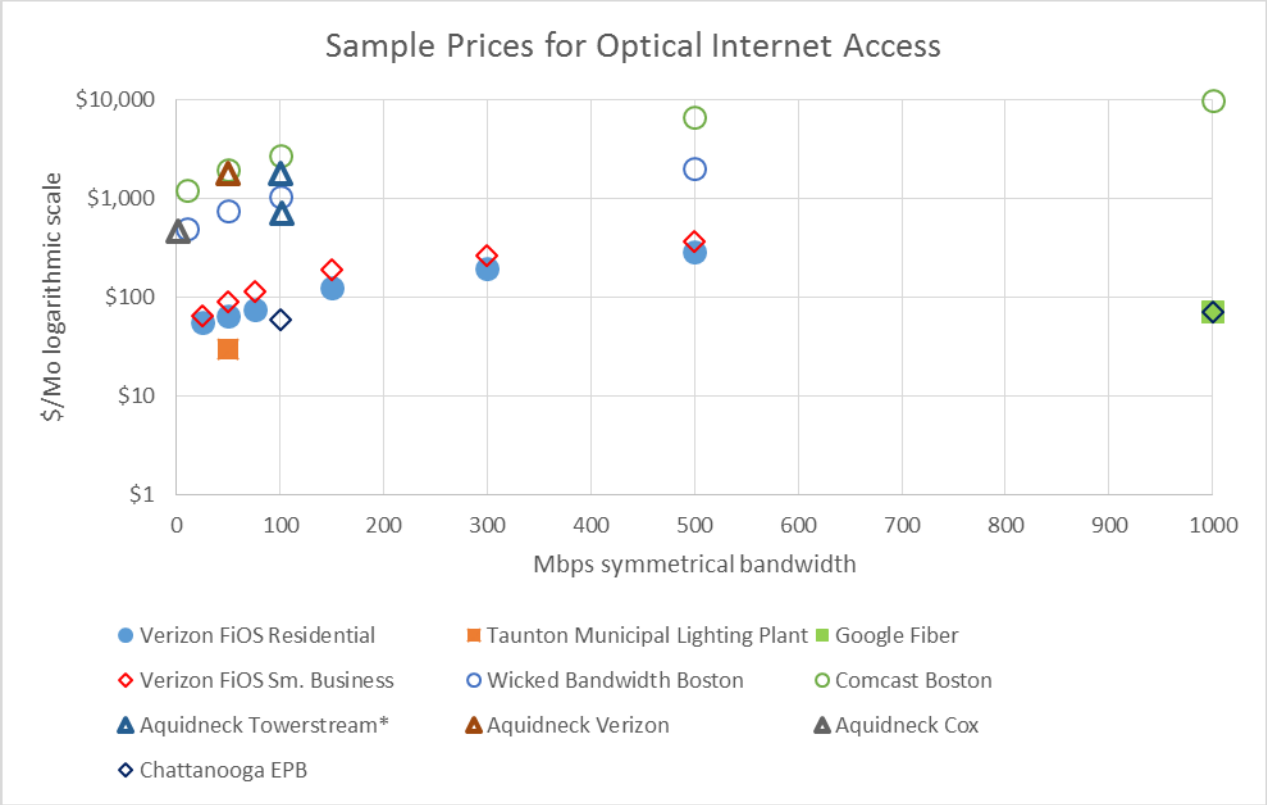

Figure 7: Advertised and Quoted Optical Internet Access Prices by Carrier[25]

Future Service Providers

Aquidneck Broadband LLC

Aquidneck Broadband LLC is a partnership that intends to announce an open access network[26] on Aquidneck Island during 1Q 2015.[27] A few details were made available to Tilson: Aquidneck Broadband will be an open access network, meaning that it will not provide services like internet access and cloud storage directly. Rather, ISPs will provide these services on leased capacity from Aquidneck Broadband.

[24] i.e. price differences are larger than they appear. E.g. the 50 Mbps price of Wicked Bandwidth is more than 10x the price of Verizon FiOS residential.

[25] * Towerstream's service is not optical, but served over a wireless microwave connection that is intended to compete with optical service. They charge a lower price if the premise has 10 or more tenants.

[26] See Glossary for definition and brief discussion of open access networks

[27] Phone conversation with Andrew Cohill, CEO Wide Open Networks, 11/17/14

The ISPs would provide retail services to end users. The partnership plans to combine OSHEAN middle-mile fiber and newly-constructed routes to create the physical layer of its backbone.[28]

Tilson has not spoken to Aquidneck Broadband LLC principals since Cox's December 18 announcement stating a future fiber rollout in the area, and therefore cannot comment on the effect of Cox's statement on Aquidneck Island LLC's ability to raise capital or on their outlook for the Middletown/Newport/Portsmouth market.

Gap Analysis and Report

As part of this exercise, Tilson analyzed extensive survey data of end user speed tests compiled by Broadband Rhode Island. Broadband Rhode Island, working with vendor Brave River Solutions, set-up a speed test that launched from the Broadband Rhode Island website and pinged a server in Providence, RI. Over 6,000 samples were collected from about 2300 unique business and residential tester addresses. While speed tests are not taken in a perfectly controlled environment, and the voluntary nature of the survey design may introduce bias, numerous speed tests measured by a single vendor using a consistent protocol are perhaps the best measure of experienced speeds across the state. [29] [30]

Note on Wireline TV/Broadband Provider Competition

Wireline TV providers are regulated by the RI PUC for their "basic cable" services. These providers offer unregulated add-on services like enhanced channel offerings, DVRs and broadband services. Cox Communications and Verizon FiOS are the predominant wireline TV providers in Rhode Island, and they co-exist and compete for broadband services in many markets. There are other providers too, like Full Channel in the East Bay area that offers bundled TV/broadband/phone.

Newport County, comprised of Newport, Portsmouth, Middletown, Jamestown and Little Compton, is the only county in Rhode Island that has a single wireline TV provider.[31] [32] While Verizon offers DSL in Newport County, that service doesn't support TV, and is not a viable broadband competitor to Cox's DOCSIS based service.

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[28] Phone conversation with Jack Maytum, Wide Open Networks, 11/19/14

[29] All speed tests are subject to exogenous factors. Examples affecting speed tests results include spyware and viruses installed on end user equipment, proxy server use in a business setting, and other factors like network congestion that may change the route packets take between the speed test server and the end user. It is not uncommon for two sequential speed tests to have slightly different results. It is very common to have consistently different results on reported speeds between separate speed test vendors.

[30] Speed test data is comprised of all tests taken between 3/23/10 and 8/3/14 on BRRI's server. Brave River utilizes a VMWare server partitioned with 2 dedicated Intel Server CPU's Xeon E5-2603 and 8 GB. The server has unrestricted access to entire Prov.net network Internet hub which runs at up to 500 MB/Sec. Previous to 2013, the server had a 75MB connection to the Prov.net network.

[31] Tom Kogut, Rhode Island PUC. Phone conversation on 11/18/2014

[32] The RI PUC's structure that enables multiple wireline providers can operate in a given market also means that franchise agreements don't expire. Therefore, as long as Cox continues to meet its service obligations for basic cable TV, it will maintain its franchise.

Speed Tests by County

The speed tests collected by BBRI show that median broadband speeds were slower in Newport County (served only by Cox wireline TV), than in Bristol County (served by Cox and Full Channel) or Washington County (served by Cox and Verizon FiOS).

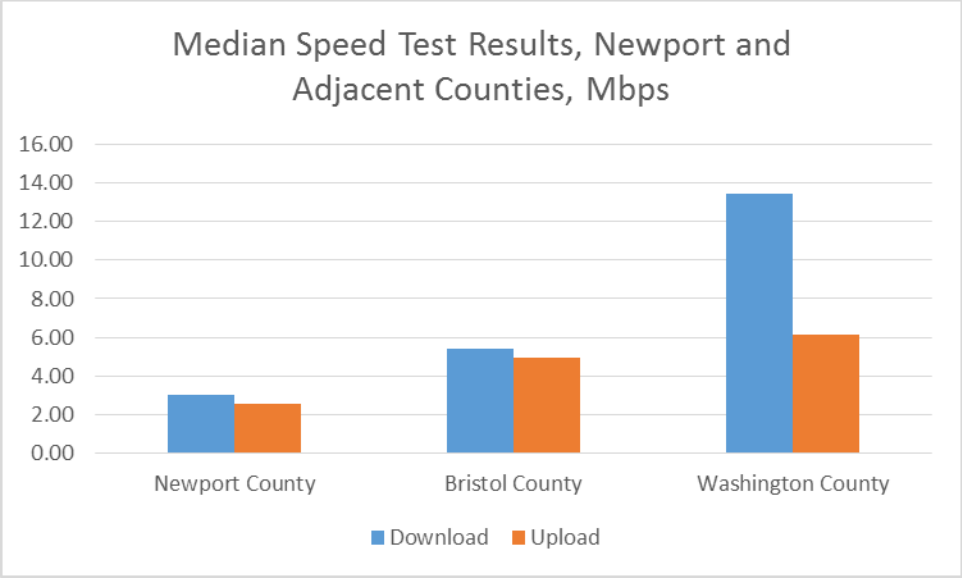

Figure 8: Median Speed Test Results by County, All Providers

In addition to looking at the median speed test results by county presented above, it's also useful to examine the distribution of test speeds on Aquidneck, and compare those speeds to another community. In this case, Tilson decided to compare the speeds on Aquidneck to all of Rhode Island in order to maximize sample size.

Speed Tests Distributions, Aquidneck vs all of Rhode Island

In the first analysis, Tilson looked at all Aquidneck testers' results (i.e. subscribers of ISPs Verizon, Cox, OSHEAN and Towerstream) and compared them to the results of all of RI. The results suggest that testers on Aquidneck experienced download speeds skewed towards the slower speeds, and a smaller percentage of testers experienced speeds in ranges needed by businesses.

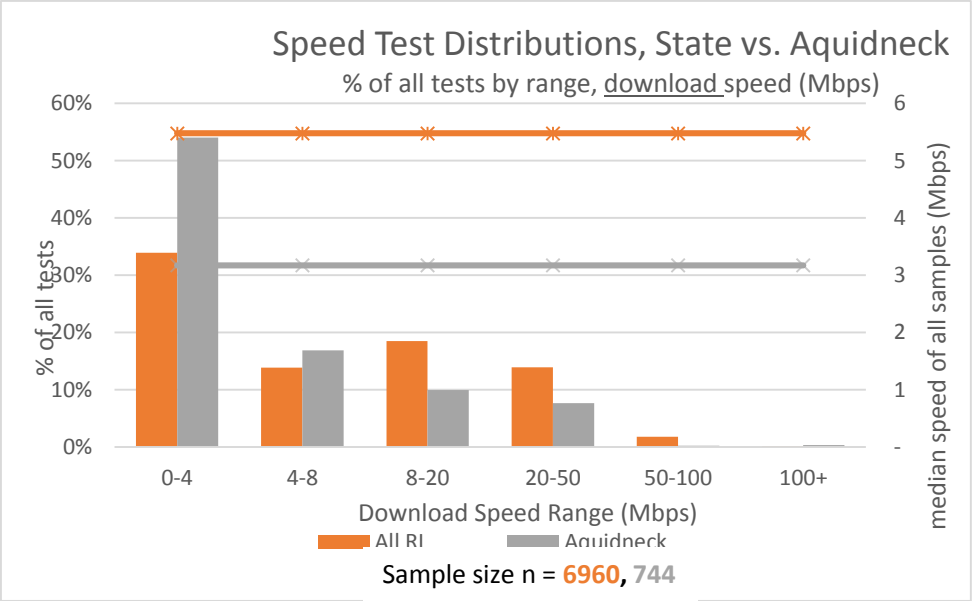

Figure 9: Comparative Speed Test Distributions, RI vs Aquidneck, Download, All Providers

Median upload speeds on Aquidneck were roughly on par with state speeds. Tilson believes this is most likely because of the way the ISPs' networks are (or were) configured on the island. Very few users Tilson spoke to subscribed to symmetric services, so a high proportion of symmetric subscribers is unlikely the underlying cause.

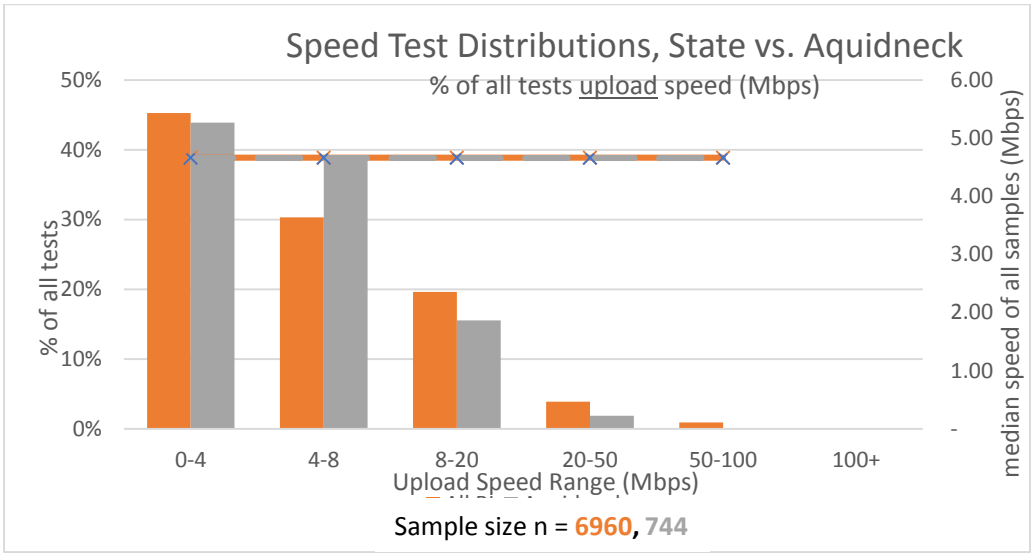

Figure 10: Comparative Speed Test Distributions, RI vs Aquidneck, Upload, All Providers

Speed Tests Results for Cox-only Users, Aquidneck vs the Rest of Rhode Island

In the second analysis, Tilson looked at Aquidneck testers that were Cox Communications customers only, and compared those test results with all Cox Communications testers elsewhere in the state. These results showed that Cox testers on Aquidneck experienced significantly slower download speeds than testers elsewhere in the state. The gap in upload speeds within the Cox tester base was narrower.

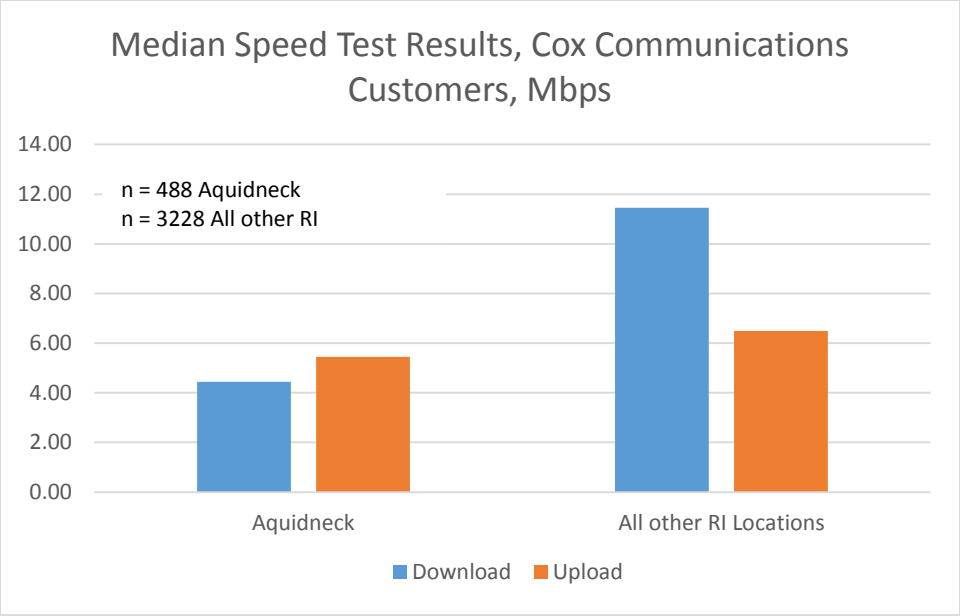

Figure 11: Comparative Speed Test Results, Cox Customers on Aquidneck vs All Other RI Locations

Summary of Gap Analysis

BBRI's speed test results suggest that Aquidneck Island experienced slower broadband speeds than the rest of Rhode Island during the test period. Newport County experienced slower speeds than adjacent counties,[33] and Cox customers on Aquidneck experienced slower speeds than Cox customers elsewhere.

Anecdotal evidence suggests that Cox's HFC "best efforts" service has dominant combined residential and business market share for broadband on the island. Interviews with stakeholders revealed persistent dissatisfaction with service reliability and actual speeds. Tilson believes that while some dissatisfaction with Cox stems from customers' sense of being captive to a single provider, that the data suggests that Cox's service on Aquidneck and in Newport County was inferior to that experienced in the rest of Rhode Island.

The analysis of the existing data has raised questions, and may contribute to existing theories about broadband performance throughout Rhode Island. Tilson believes this analysis will place a lot of scrutiny on the speed test process – e.g. who took it, what protocol was used, and whether the sample represents a relatively uniform distribution of subscribed speeds. Another important variable is when the speed tests were taken, particularly important if Cox's network upgrades on Aquidneck Island were recent (see date distribution graph below). With this in hand, the next logical step may be a separate speed test survey dedicated to resolving the question of relative performance of Aquidneck vs the rest of Rhode Island.

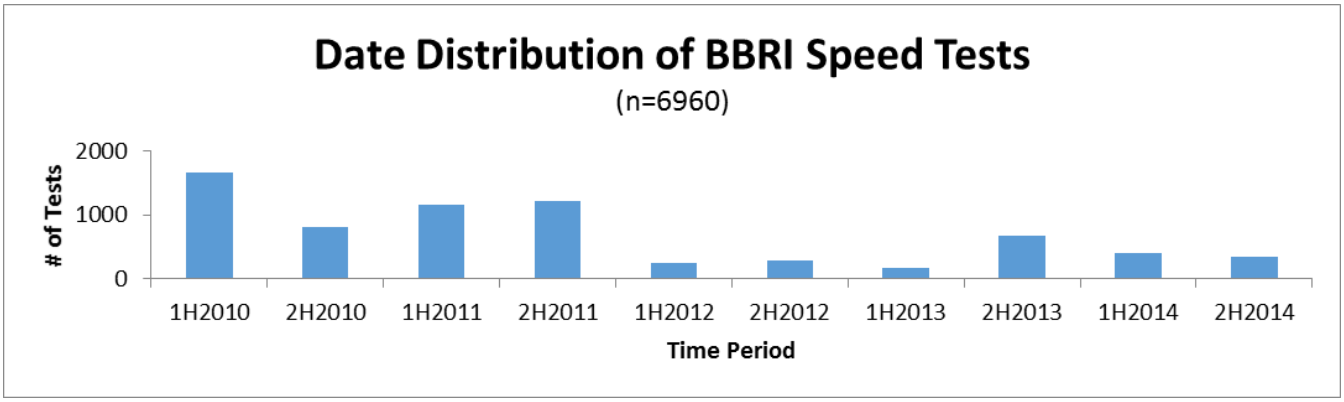

Figure 12: BBRI Speed Test Dates by Half Year Periods

[33] The three Aquidneck Island towns have faster median speed test results than all Newport County towns as a whole.

High Level Solution Designs and Cost Estimates

The 2013 completion of OSHEAN's Beacon 2.0 fiber optic network delivered significant middle-mile infrastructure on Aquidneck Island with good proximity to many of the island's businesses and tower assets (see Figures below). Tilson has leveraged this infrastructure to provide two high-level technical designs – a Fiber to the Premise design (FTTP) and a wireless design.

Figure 13: OSHEAN Network and Newport Chamber of Commerce Business Locations

Figure 14: OSHEAN Network and Existing (blue) and Proposed (white) Towers for Wireless Network

Operating Models

Tilson envisions four potential operating models for addressing the residential and business service gap on Aquidneck. These models are a not an exhaustive list of options to improve broadband access in the state, but rather build on the technical solutions described above. For example, they do not contemplate legislative action or the possibility that a new provider will seize the market opportunity and enter and disrupt the market for internet access on Aquidneck Island.

1. Private Model. The towns of Newport, Portsmouth and Middletown partner with an incumbent ISP (either Verizon or Cox) or a new ISP (e.g. Aquidneck Broadband LLC), to upgrade existing facilities and/or build new facilities on the island. These upgraded and/or new facilities would offer faster, more reliable speeds. The private provider would construct, maintain, operate, and

provide service on the network and would cover all ongoing operating costs. It is possible that the provider would require some capital subsidy in order to build/upgrade the network to reach all addresses in Newport, Portsmouth and Middletown.

Pros (Incumbent): Use existing, proven technology and leverage existing assets.

Cons (Incumbent): Likely a higher price for consumers than alternate options. No guarantee of future upgrades in absence of a competitive environment. Reduced likelihood of a future competitive environment (i.e. new entrants will find it more difficult to enter this market).

Pros (New ISP): Consumer and regional economic development benefits associated with an improved competitive environment (i.e. increases in domestic and business productivity resulting from lower price and faster broadband connections).

Cons (New ISP): Performance risk associated with partnering with a new, relatively lightly capitalized service provider.

2. Public Model. The towns of Newport, Portsmouth and Middletown fund, build and operate a broadband network. This model could work with either the FTTP or wireless solutions described above.

   Pros: Leverage municipalities' lower cost of capital. Ensures municipal control over network. Exempts network owners from paying state telecommunications infrastructure tax. Likely a lower price for consumers. Potential operating income.

   Cons: Requires that municipal governments become an internet service provider, an area in which they likely have little expertise. Requires close alignment of municipalities. Operating loss risk if venture loses money.

3. Public/Private Partnership. Newport, Portsmouth and Middletown pursue a joint venture with a private carrier to build a network to all premises on the island. The municipalities fund the network (either FTTP or wireless), and a private partner constructs, maintains and operates the network. There are a variety of ways to structure the partnership. For example, a joint venture with combined town/private ownership could fund, build and own the network. Alternatively, the municipalities could fund the network, hire a third party EPC to build the network, and work with an ISP to maintain and operate the network. If a municipality retains control over the network, it could have the right to replace the ISP in the event of non-performance.

   Pros: Leverage municipalities lower cost of capital. Ensure municipal control over network while leveraging the expertise and assets of an ISP. May exempt network owner from paying state telecommunications infrastructure tax. Likely a lower price for consumers.

   Cons: Requires close alignment of municipalities and ISP. Initial partnership structure must reflect community needs, risk tolerances, and ISP competencies. Complex deal structure. ISP will likely require customer guarantees or operating capital subsidy.

4. Non-Profit OSHEAN Reseller. A non-profit is formed to resell OSHEAN internet access to commercial customers within a given distance parameter. This model is within OSHEAN's charter parameters, and OSHEAN is willing to consider the model whereby it provisions and serves individual customers via a reseller.[34] While OSHEAN is willing to consider this model for businesses, provisioning and serving individual residences would be complex, and OSHEAN is not equipped to serve this market. If the non-profit were to service this market, it would have to take on virtually all operational responsibilities and use OSHEAN as a wholesale provider.[35]

   Pros: Low initial capital investment. Gets business access to the OSHEAN network's low cost bandwidth.

   Cons: Requires close alignment of municipalities, OSHEAN, and non-profit. May necessitate serving the residential market as a second phase contingent on the success of the business-only model.

Model	Who Funds	Who Builds	Who Owns	Who Operates	Who Takes Revenue Risk	Taxes? (Y/N/?)
1a. Private - Incumbent	Carrier – possilbe coverage subsidy	Carrier	Carrier	Carrier	Carrier	Yes
1b. Private – New ISP	Carrier – possible coverage subsidy	Carrier	Carrier	Carrier	Carrier	Yes
2. Public	Municipalities	Municipality / Contractor	Municipality	Municipality	Municipality	No
3. Public Private Partnership	Municipalities	Municipality/ Contractor	Municipality	Carrier	Structured commensurate with risk	tbd
4.Non Profit OSHEAN Reseller	Non-Profit (Donations, Bonds, Grants)	Non-Profit/Contractor	Non-Profit	Non-Profit	Non-Profit	No (probably)

Table 5: Business Model Options

Network Options

Tilson Identified three high level network solutions to close the identified broadband service gap. The first option is a coaxial cable infrastructure investment. Under this scenario Cox or another cable provider works in partnership with the three municipalities to replace derelict copper, split nodes, and make fiber more available to customers. The second option is a new fiber to the premise network that can be operated and funded on a public, private, or hybrid basis. A third option is to use deploy a more extensive wireless broadband network to serve the island. Using 4G LTE equipment or fixed wireless

[34]Conversation with David Marble, President of OSHEAN on 11/4/14.

[35] The residential reseller/OSHEAN reseller model would be similar to the structure between Taunton Municipal Lighting and Plant and OSHEAN. See http://www.tmlp.net/#&panel1-1 for customer-facing details.

installed on five existing and five new towers in the area, the network could provide fast broadband to every home on Aquidneck.

Option 1. New hybrid fiber coaxial networks cost approximately $45,000 per mile to build. The comprehensive plans for Newport, Middletown, and Portsmouth indicate that the island has approximately 206 miles of roads. This implies a total capital cost of $9.3 million to build the new network. This model does not place any operating cost burden on the municipal governments because a third party assumes all business responsibilities.

Option 2. According to the U.S. Census there are approximately 35,000 housing units and business on Aquidneck Island. Experience with fiber to the premise projects indicates that capital costs run in the range of $2000 to $3000 per premise, depending on population density, take rate, and the division of costs between customers and providers. Assuming this range of prices, Tilson estimates that a new FTTP network with the potential to serve every home and business on Aquidneck would cost between $70.9M and $106.4M. The line item estimates are imputed from similar cost estimates based on the total cost.

Cost Per Premise	Low $2,000	Mid $2,500	High $3,000	Share of Total Cost
Fiber Cable (all counts)	$4,067,428	$5,084,285	$6,101,142	6%
Aerial Construction	$13,374,919	$16,718,648	$20,062,378	19%
Under Ground Construction	$29,992,291	$37,490,364	$44,988,437	42%
Splicing	$5,269,197	$6,586,497	$7,903,796	7%
Make Ready	$5,058,558	$6,323,197	$7,587,836	7%
Professional Services	$6,155,002	$7,693,752	$9,232,502	9%
Contingency	$7,030,913	$8,788,642	$10,546,370	10%
Total Capital Cost	$70,948,308	$88,685,385	$106,422,462	

Table 6: FTTP Capital Cost Estimate

Without a business plan in place, it is impossible to precisely estimate what the operating costs of such a network would be. These costs are highly dependent upon the scale of the operator, take rate, and the fee structure of the network. The operating costs listed below give the components of operating a FTTP network and a range from $3.4M to $7.9M.

Operating expenses	Low	Mid	High
Pole Attachment Fees	$103,050	$133,965	$164,880
Maintenance & Repair	$1,064,225	$1,995,421	$3,192,674
Bandwidth	$360,000	$360,000	$360,000
Fixed G&A	$1,100,000	$1,100,000	$1,100,000
Variable G&A	$780,431	$1,951,078	$3,121,726
Total	**$3,407,706**	**$5,540,465**	**$7,939,279**

Table 7: FTTP Operating Cost Estimate

Pole attachment fees are paid to the owner of the utility poles on which the fiber is mounted. On Aquidneck Island, National Grid and Verizon own over 90% of these poles. Fees usually range between $10 and $16 per pole. Tilson estimates that there are 50 utility poles per road mile, which yields an estimated total of 10,305 poles. Maintenance and repair ranges from 1.5% to 3.0% of the capital costs of the network. These maintenance estimates are equal to 1.5%, 2.25%, and 3.0% of the corresponding capital costs. Fixed G&A reflects costs such as rent, electricity, field technician labor, and legal advisory this is based on previous network designs. These do not scale significantly as the network grows. Fixed G&A costs include all the customer service, billing, and administration associated with each customer. Tilson estimated a per customer cost of $220 and take rates of 10% to 40% to obtain the variable G&A estimates. Considering all of these variables, Tilson estimates that a fiber optic network covering all of Aquidneck Island would cost between $3.4 and $7.9 million to operate annually. For comparison, if the network operator obtained 9000 customers, or about 27% of all premises, at an average monthly subscription price of $70, the business would generate $7.5 million in revenue. The experience of similarly disruptive FTTP networks suggests that such figures are attainable.

	Take Rate	Gigabit Price
Chattanooga, TN	40%	$70
Leverett, MA	65%	$80
Kansas City, MS	75%	$70

Table 8: Take Rates and Corresponding Prices of FTTP Broadband Projects

Chattanooga EPB was the nation's first municipal gigabit network and took several years to achieve its market share. However, the new Google Fiber project in Kansas City and municipal broadband network in Leverett Massachusetts quickly reached their take rates. The projects in Chattanooga and Kansas City have succeeded despite crowded markets with strong cable and telecom providers offering broadband products. This success appears to be replicable.

Option 3. In this model new antennas and radios are installed on towers throughout the area to provide LTE-equivalent service to homes and businesses. Tilson identified five existing towers that can serve as potential sites. The map below also identifies five additional sites that would fill the current gaps in coverage. The route utilizes OSHEAN fiber where possible for connection to the internet via a nonprofit reseller. Model includes the cost of installing equipment at customer homes. The map below shows the tower locations and coverage footprint of a potential wireless broadband network. Blue triangles indicate existing towers while white triangles denote proposed towers.

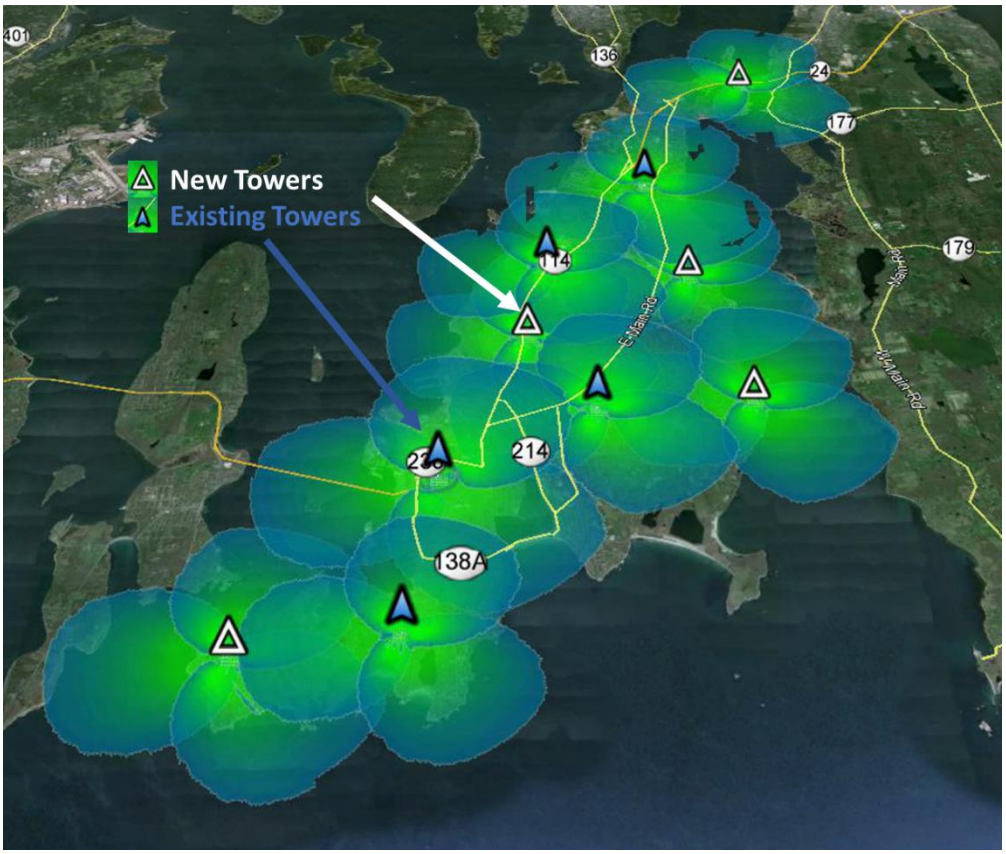

Figure 15: Wireless Broadband Coverage Area

Tilson estimates that the macro sites will entail construction costs of between $1.5 and $2.3 million including new tower erection, antenna installation, fiber construction, legal services, engineering, and permitting, and a 10% contingency. Major cost variables include the number of sites required and fiber construction costs. The major capital cost is installation of the customer's equipment, which can cost as much as $280 in labor and material per site. If 30% of premises take the service, the total cost of installation will be approximately $2.4 million. If the municipal governments pursue a public operating structure and public subsidy, they will need to decide whether or not to capitalize this large expense or leave it as the customer's responsibility.

	Low	Mid	High
Tower Construction	$1,140,000	$1,340,000	$1,740,000
Fiber Construction	$75,000	$125,000	$200,000
Professional Services	$120,000	$120,000	$120,000
Contingency (10%)	$133,500	$158,500	$206,000
Total Capital Costs	**$1,468,500**	**$1,743,500**	**$2,266,000**
Take Rate	20%	30%	40%
Customer Installs	$1,621,885	$2,441,547	$3,255,396

Table 9: Wireless Capital Cost Estimate

The operating costs of this network are difficult to estimate in the absence of a finalized business model. That being said, Tilson estimates that this network could be operated for between $2.4 and $4.0 million per year. Tilson's estimates are based on previous experiences and recent quotes. Most of the operating cost estimates resemble those of the FTTP network. While the technology is different in each case, the actual service to the customer is very similar, and entails similar costs. Variable G&A is lower due to lower forecasted take rates. Wireless internet service providers seldom see take rates over 20% in their communities. Fixed G&A is higher due to added technician costs associated with working on towers. Electricity and rent are similar. Pole fees are significantly lower due to the small number of poles needed to connect to the OSHEAN backbone.

Operating expenses	Low	Best	High
Pole Attachment Fees	$1,500	$3,250	$6,400
Maintenance & Repair	$44,055	$69,740	$113,300
Bandwidth	$360,000	$360,000	$360,000
Fixed G&A	$1,244,000	$1,250,000	$1,262,000
Variable G&A	$780,431	$1,560,863	$2,341,294
Total	**$2,429,986**	**$3,243,853**	**$4,082,994**

Table 10: Wireless Network Operating Cost Estimate

Economic Benefits

Research has shown that investments in broadband infrastructure can dramatically improve economic development in rural communities. Broadband enhances productivity, makes firms more efficient,

facilitates commerce, attracts jobs, increases consumer options, and saves residents money. Recent research has shown that faster broadband also improves GDP growth rate (Rohman and Bohlin, 2011).[36]

By transferring values from peer-reviewed economic valuations of the impact of broadband on communities, Tilson estimated the impact of improved broadband infrastructure on Aquidneck Island. This focuses on increasing gross domestic product (GDP), creating jobs, and enhancing consumer well-being on the Island.

The economy of coastal Rhode Island and Massachusetts has contracted in real terms over the past ten years. According to the US Bureau of Economic Analysis, the region experienced a net average annual real GDP decrease of 0.34% between 2003 and 2013. The US economy as a whole, by contrast, grew at an average annual rate of 1.6% over the same period.[37] Without conducting an extensive survey of spending trends on island over the past ten years, it is impossible to precisely estimate the economic product of Aquidneck Island alone. This is because some economic data, such as productivity and output, are not tracked on the local level. Therefore, metrics for GDP growth in Portsmouth, Newport, and Middletown were not available. These metrics are, however, tracked at the metropolitan statistical area (MSA) level. The most comparable of which, in terms of its profile of economic activity, is Barnstable County in Massachusetts. Barnstable is similar in terms of its economic dependence on tourism, military installations, seasonal residents, and coastal environment.

This analysis assumed the US ten year GDP real growth rate of 1.6% as the baseline growth rate for Aquidneck. The baseline growth rate is crucial to estimating the economic impact of the new network, because the economic community widely agrees that broadband affects economies by boosting the GDP growth rate. In the case of Aquidneck, the mechanism for this impact is boosted productivity and innovation through faster connections. While it is impossible to know exactly how much connection speed will improve, we modeled the impact of a 50% to 200% average increase in speed. Note that a fiber to the premise network gives the user the option of speed several orders of magnitude faster than what is commercially available in Aquidneck, at least for small businesses and residences. This analysis assumes that for the next ten years the average user will only demand speeds two to four times greater than their current usage.

Using Rohman and Bohlin's results (2011), we estimated that a new network has the potential to increase the economic output of the three municipalities by between $247 million and $1.0 billion over ten years. The lower benefit estimate is over 2.5 times greater than the total cost of the FTTP network. Because broadband boosts GDP growth rate, the investment behaves like compound interest. For example, in the second year of the network, Tilson estimates that a major broadband investment will increase economic output by $8.1 million. Ten years later, the model shows network contributions to GDP equaling $106 million. This is because as tech businesses and knowledge workers move to the area or grow, they tend to attract additional services and improve their productivity.

There are numerous case studies that illustrate the transformative impact of broadband. Lake County, Florida, a rural area north of Orlando, saw its economic output double relative to its neighboring

[36] Rohman, Ibrahim Kholilul and Erik Bohlin. 2001. "Does Broadband Speed Really Matter for Driving Economic Growth: Investigating OECD Countries." Department of Technology Management and Economics, Chalmers University of Technology, Gothenburg, Sweden.

[37] U.S. Bureau of Economic Analysis, 2014. These values account for inflation by keeping all figures in 2009 dollars.

counties within five years of a major broadband build out to the county's community anchor institutions (Ford and Koutsky, 2005).[38]

In addition to increasing local GDP, broadband development also creates jobs. Unlike economic output, which typically takes at least two years for communities to begin reaping the full effects of an investment, job creation occurs immediately. Broadband investments affect employment in three ways.

- Direct Jobs (telecommunications technicians, construction workers, and manufacturers of telecom equipment)
- Indirect Jobs (upstream suppliers and sellers of raw materials)
- Induced Jobs (from the household spending resulting from the new direct and indirect jobs)

These jobs tend to be higher paying, technology-oriented jobs, some of which are temporary but many are stable and more or less permanent improvements to the region's economy. A study of broadband development in rural Kentucky found that every 1 percent increase in broadband adoption yielded a 0.14 percent increase in employment (Shideler et al. 2007).[39] We assume that job growth parallels GDP growth at a rate of one job per $93,000 of additional output. This reflects the current GDP to job ratio in the area. This factor suggests that between 500 and 2000 new jobs will be created in the Aquidneck area (not all of these will be in on the island itself) by 2026 as a result of major broadband investment. Assuming these jobs pay a technology industry salary of $73,000, Tilson estimates that they will receive between $235 and $959 million in additional wages over ten years.

Lastly, broadband investments improve consumer wellbeing. Consumers are not necessarily better off just because economic output increases. An increase in GDP just means that they are spending more. That being said, broadband access empowers consumers to both pay less for goods than they otherwise would have purchased and to purchase goods and services that were not available before. For example, broadband allows consumers to enjoy almost limitless video content for little or no cost. Without it, consumers pay more to rent films and or subscribe to satellite television. In economic lexicon this phenomenon is known as "consumer surplus".

For the purposes of this exercise, consumer surplus is defined as the amount that consumers benefit from purchasing a product for a price that is less than what they would be willing to pay. In a study of the 40 million U.S. households with access to broadband, Greenstein and McDevitt (2009) found that broadband access increased consumer surplus by between $120 and $167.50 per household, per year.[40] The analysis used the Census figure of 29,000 housing units on Aquidneck as a proxy for the total number of households. This translates to a total increase in surplus of between $41.8 and $58.4 million over ten years.

The table below illustrates the economic impact on Aquidneck Island's communities of a major broadband investment in the year 2020 in terms of GDP, wages, and consumer surplus.

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[38] Ford, G. and Koutsky, T. 2005. Broadband and Economic Development: A Municipal Case Study from Florida. *Review of Urban & Regional Development Studies. Vol: 17, Pages: 219-229.*

[39] Shideler, D., Badasyan, N. & Taylor, L. 2007.The Economic Impact of Broadband Deployment in Kentucky. *Regional Economic Development*. Vol: *3*, Pages: 88-118.

[40] Greenstein, S. and McDevitt, R. 2009. The Broadband Bonus: Accounting for Broadband Internet Impact on U.S. GDP. NBER Working Paper No. 14758.

		Additional Economic Activity - 2020		
		GDP	Wages	Consumer Surplus
Speed Improvement	1.5X	17,086,386	17,106,820	3,487,924
	2X	34,248,506	34,314,814	4,178,243
	4X	68,800,840	69,036,115	4,868,561

Table 11: Annual Economic Benefit

The table below shows the estimated ten year economic impact of a major broadband investment.

		Ten Year Total Economic Improvement		
		GDP	Wages	Consumer Surplus
Speed Improvement	1.5X	247,145,875	236,271,539	41,855,092
	2X	496,525,296	474,920,086	50,138,913
	4X	1,002,065,110	959,444,550	58,422,733

Table 12: Ten Year Net Economic Benefit

Using data on the effective state and local tax rates for residents of the state of Rhode Island, we can estimate the approximate increase in tax revenue from the jobs created by the network.[41] Approximately 10% of the wages from the network build will be paid in state and local income, sales and property taxes. Note that this only accounts for the tax increase associated with new jobs. It does not account for the property tax increase resulting from appreciating land and buildings, which is likely to happen. The table below shows annual additional tax revenue from the network construction. Tilson estimates that a broadband investment has the potential to increase state and local tax revenue by between $500K and $2.0 million per year.

		Speed Improvement		
		1.5X	2X	4X
Tax Level	Sales	533,047	1,069,253	2,151,197
	Property	518,241	1,039,552	2,091,441
	State Income	503,434	1,009,850	2,031,686

Table13: Annual Additional Tax Revenue 2020

Overall, Tilson believes that a broadband investment on Aquidneck would be a strong contributor to economic development in the region and offer a range of public benefits. Improving broadband access would supplement the region's traditional economic activities, while also supporting conditions needed to foster small business growth. Due to these added public benefits, Tilson recommends that investment in broadband infrastructure is considered not only through a lens of the network's profitability, but also as a long-term investment in the sustainability of the community and economic development in the region.

[41] Institute on Tax and Economic Policy. 2009. "Who Pays: A Distributional Analysis of the Tax System in all 50 States."

Conclusion

The communities of Middletown, Newport and Portsmouth on Aquidneck Island are underserved relative to state norms for broadband access. This can be measured in several ways: the number of wireline TV providers offering broadband speeds over 10Mbps across Aquidneck; BBRI's speed test data showing median speeds below state and adjacent county numbers; the relatively high prices quoted for dedicated, optical service;[42] and the feedback from business leaders and residents on Aquidneck.

The notable exception to the underserved on Aquidneck is the education, government, non-profit and healthcare sectors, which are served by the recently deployed OSHEAN network. While OSHEAN is precluded from serving the residential and business sectors directly by its charter, it is capable of serving these sectors indirectly via a wholesale or resale arrangement. Tilson's high-level network designs leverage the OSHEAN infrastructure to reduce the cost of deploying a broadband network for the island.

As the state of Rhode Island continues to contemplate the broadband future of Aquidneck, Tilson recommends that it should consider these issues:

1) To what extent is the Aquidneck market ripe for a self-sustaining for-profit entity to disrupt the market for internet access? Is that entity likely to meet economic development goals on the island?
2) Will an increased network investment by Cox that yields better service (higher realized speeds, greater reliability) suffice for Aquidneck's economic development goals? Or does the island need another high speed provider with a similarly broad footprint to ensure a competitive environment in the long term.
3) Given the unregulated nature of broadband, is it imperative to Aquidneck's economic development goals that municipalities play an active role in the delivery of the service to ensure adequate coverage, speeds, reliability and pricing? If so, Tilson recommends exploring options 2-4 outlined in the Operating Models section above.

[42] See prices above for Leverett, MA and Chattanooga, TN. Also, see like Taunton Municipal Light and Power, $29.95/month for 50/50 dedicated optical broadband. http://www.tmlp.net/page.php?content=highspeed_home

Appendix A

Cox Network (Orange) Superimposed on OSHEAN Network (Blue)

The Newport Daily News Newport Daily News 12/18/2014 Local (0-ndn_a_1_12182014_a_03.pdf.0) Page A03

Cox to bring high-speed to island by '16

By Matt Sheley
Staff writer

Cox Communications is planning to bring high-speed fiber-optic broadband Internet service to homes across Aquidneck Island by the end of 2016.

In response to a recent story in The Daily News about efforts to bring the broadband service to the island, Cox spokesman Eric Wagner said the communications company already manages about 200 miles of the high-end service in Newport, Middletown and Portsmouth.

Wagner would not disclose how many business and residential customers tap into the network on the island, saying that is proprietary information. He said the cost of the service varies, but is far less than the thousands of dollars a month that has been quoted to those involved in the effort locally.

As part of a statewide initiative, Aquidneck Island customers could expect to see 1 gigabit (Gb) per second service available to their homes within two years, Wagner said.

'According to Broadband RI, Rhode Island ranks No. 1 in Internet speed and No. 3 in Internet coverage. Our 200-plus miles of fiber on the island contribute to this.'

ERIC WAGNER
Cox Communications spokesman

"Broadband Internet has become essential to compete as a business and even as an individual navigating a crowded job market," Wagner said. "It is necessary for education and communication, and Cox is committed to helping our customers make life's most important connections."

Dissatisfied with the speed, cost and quality of the Internet service available locally, officials, business leaders and residents have been discussing ways to address the issue, which is seen as essential to attracting and retaining businesses.

Fiber broadband is billed as being 50 to 60 times faster than traditional Internet service. The higher the speed, the better the quality of the experience and lower the likelihood of blurry, slow loading pictures.

The matter is the subject of a study by a consultant working through the state's economic development agency, Commerce RI. That report is expected to be completed by the end of the year or in the first quarter of 2015.

The town of Middletown's Economic Development Advisory Committee has scheduled an informational briefing on Tuesday, Jan. 13, at 4:30 p.m. at Town Hall to learn more about the lack of high-speed service, seen by some as a major impediment to growing the local economy. Matthew Wainwright, Middletown's technology director; and members of the Aquidneck Island Broadband Project are scheduled to speak. Newport and Portsmouth officials have been invited to attend.

Wagner said fiber-based Internet has been available to Aquidneck Island since 1999. Although he would not name specific organizations, Wagner said there are local hospitals, universities, government groups and commercial businesses in the area that use the service.

According to Cox, more than 90 per cent of the businesses on Aquidneck Island are located within 1,500 feet of the fiber network.

"We are not aware of any companies that have left Aquidneck Island due to insufficient Internet bandwidth," Wagner said. "In fact, according to Broadband RI, Rhode Island ranks No. 1 in Internet speed and No. 3 in Internet coverage. Our 200 plus miles of fiber on the island contribute to this, as does 1 gigabits per second to 10 gigabits per second speeds for businesses."

Cox Communications applauds municipal officials and others for working on the issue, Wagner said, and welcomes further discussions in the future.

"Cox believes governments can play a positive role in providing communications services in truly unserved areas where no private alternative is available," he said. "Public-private partnerships and government-owned networks can fill gaps in coverage, but we do not believe Aquidneck Island falls into this category.

"We welcome the discussion and look forward to educating Middletown and Aquidneck Island leaders about Cox's existing network capacity and future plans."

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Glossary

Data Over Cable Service Inteface Specification (DOCSIS) – A telecommunication standard developed by CableLabs that permits the transmission of broadband data over existing HFC infrastructure. DOCSIS 2.0 was released in 2001, and increased upstream speeds. DOCSIS 3.0 was released in 2006, and significantly increased down- and upstream transmission speeds. A DOCSIS 3.1 standard was released in 2013, and promises to significantly increase speeds if adopted by cable companies.

Digital Subscriber Line (DSL) – a technology that transmits data signals over traditional phone lines (twisted pair) without interfering with voice calls.

Fiber to the Premise (FTTP) - a local loop architecture that uses optical fiber as a physical medium

Hybrid Fiber Coaxial Network (HFC) – A network design used by cable companies that is comprised of a combination of optical fiber and coaxial cable in different portions of the network. Typically the fiber optic cable runs from the cable head-end to serving nodes. Coaxial cable runs between the nodes and end user homes and businesses.

Internet Service Provider (ISP) - A firm that provides services for using the internet. These services include internet access, domain name registration and web hosting.

Last Mile – the final (or first) leg of a telecommunications network that reaches the customer. Local loops are often provisioned over the last mile of a network, which can be twisted pair, coaxial cable, optical fiber or a wireless signal.

Local Loop – The circuit that connects the demarcation point of the customer premise to the edge of the service provider's network. The edge of the service provider's network can be the phone company's central office, the cable company's head end, or any location with networking gear.

Open Access Network (OAN) – A network that provides wholesale access to network infrastructure or services at fair and reasonable prices, and on non-discriminatory and transparent terms. Open access arrangements are used in dark fiber networks, mobile networks, undersea cables, etc. OANs are intended to promote competition, maximize consumer choice, and lower prices in a scenario where a shared network infrastructure is more affordable and less risky than building networks from scratch.

In the context of municipal broadband networks, an Open Access Network separates the network owner from the retail service provider. The network owner does not provide retail services. There are two primary OAN business models: Two-Layer and Three-Layer OANs.

In a Two-Layer OAN, the network owner manages and maintains the network's physical assets. Multiple retail service providers sell services like internet access, private data networking and voice calling by purchasing wholesale access from the owner/manager. This model is most commonly deployed in dark fiber networks, where the owner is managing a passive network. If the network is lit, the Two-Layer OAN necessitates that the owner-operator manage and maintain network electronics as well.

In a Three-Layer OAN, network ownership and management is split. The network owner, usually a public or public/private entity, owns the assets. A network manager, under contract to the network owner, maintains the network's physical assets and electronics. Multiple retail providers sell IP-enabled services to end users by purchasing wholesale access from the network manager.

Point of Presence (POP) – An interface point on a telecommunications network, where interconnections are made between multiple carriers, or between a carrier and its customer.

Verizon FiOS – A bundled communications service offered by Verizon that offers voice, internet access and TV programing over a FTTP infrastructure

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